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Lyndon B. Johnson Space Center



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Validity Test for Linear Error Analysis

In linear, nonsequential, error analysis, batched data are used to obtain estimates which have the minimum error consistent with the completeness and accuracy of the data. This method is frequently compared to the more lengthy Monte Carlo technique. Under certain circumstances the two techniques are equivalent with the most important factor for equivalence being convergence. To determine whether the estimation process simulated by linear error analysis will converge, a new criterion, based on an extension of classical observability, has been developed. The particular application of this technique is with groups of batched navigation data where the statistics of the estimation errors are derived with classical minimum-variance methods.

The extended observability describes the extent to which the navigation is estimating the real world. The error ellipsoids are described by an asphericity factor. This factor measures the extent to which the shape of the ellipsoid is distorted from a spherical configuration. The extent to which the true error ellipse is represented by the estimated error ellipsoid is related to the observability. For instance, if the major axes of the ellipses are colinear, the overlap and thus the observability will be excellent; if the major axes are at right angles, the observability will be poor and the possibility of an error in the estimate will be greater.

Since alignment of the axes provides the most favorable observability, it can serve as the basis of the observability criterion. From the normalized asphericity factors, orientation of the axes may be obtained through a "sphericity transformation". From the transformation matrix a single, normalized "observability parameter" can be defined. This parameter has a value of 1 for maximum observability, 0 for neutral observability, and is negative for degraded observability.

If degraded observability is indicated, a failure likelihood test must be applied. The probability that error may arise depends on the distribution of the real and estimated errors, and may be calculated by a method using the orientation of the ellipses and existing techniques.

Note:

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